California High Speed Rail Authority

Dairy Impacts

Effect of noise, vibrations and electromagnetic fields from a high-speed rail system upon dairy production

Agricultural Working Group White Paper

Approved: 7/23/12

BACKGROUND

The California High Speed Rail Authority (CHSRA) proposes to establish a new railway in the San Joaquin [Valley]. The new rail alignment is proposed to be generally along existing transportation corridors but will impact farmland, where such land lies between urban and commercial [parcels] in the valley by either being adjacent to or on existing farmland where the route leaves an existing corridor. Most, if not all, of the Valley counties through which the railway is proposed to travel have Right-To-Farm Ordinances which make reference to "customary and/or traditional" agricultural practices. The proposed project has raised questions and concerns regarding its impact on many established and customary agricultural practices and consequent potential imposition of new regulatory restrictions. Customary agricultural practices found in the Valley are as varied as is the diversity of agricultural products and commodities produced. The San Joaquin Valley as a natural resource is unique to the state, the nation, and arguably the world by the quality and quantity in the diversity of its agriculture.

The CHSRA has created a "technical" agricultural working group to assist the CHSRA in responding to the more technically oriented questions and concerns that have been asked regarding impacts to agriculture resulting from activities during the construction phase and the daily operation of the High Speed Train. The agricultural working group membership is comprised of members in possession of technical expertise in various categories of agriculture activities and infrastructure.

ISSUE

The proposed project has raised concerns with regards to dairy farming due to possible effects of noise, vibrations and stray current on milk production, breeding, and overall health of the dairy animal.

DISCUSSION

NOISE

Noise can be defined as unwanted sound, either chronic or intermittent, from a variety of sources in the environment. Noise can be considered to be a stressor if it occurs where animals are located and if it affects their behavior and productivity or induces physiological changes as shown by various studies. Noise, such as the sound of a truck horn, was shown to increase the heart rates of free-ranging cattle (Arave et al., 1991), while cattle habituated to the sounds and sights of cars and trucks will readily graze along highways and seldom react (Grandin, 1997). The sound threshold expected to cause a behavioral response by animals is 85 to 90dB (Espmark, et al. 1974; Manci, et al., 1988) but the actual noise limit for cattle though is unknown (Anonymous, 2001). Noises greater than threshold have provoked retreat, freezing, or strong startle response (Manci, et al., 1988). The dissipation of high-speed train sound to the 90db threshold is about 350 feet when unmitigated.

Measures often used to assess responses to stressors include body temperature, heart rate, respiration rate, feed intake and eating pattern, digestibility of feedstuffs, body weight loss or gain, immune function, secretion and peripheral concentrations of various hormones in plasma, milk yield, milk composition and quality, udder health, pregnancy status and viability of offspring. The most important measures are general health and productivity (Moberg, 1987).

The noise research is broad in general, encompassing both wild and domestic in the same study and for a variety of livestock species. One exception is the Bradley, et al report on Effects of Low-altitude Aircraft Overflights on Domestic Turkey Poults. This paper places the panic threshold at 100db. Similar specific studies for cattle were not found.

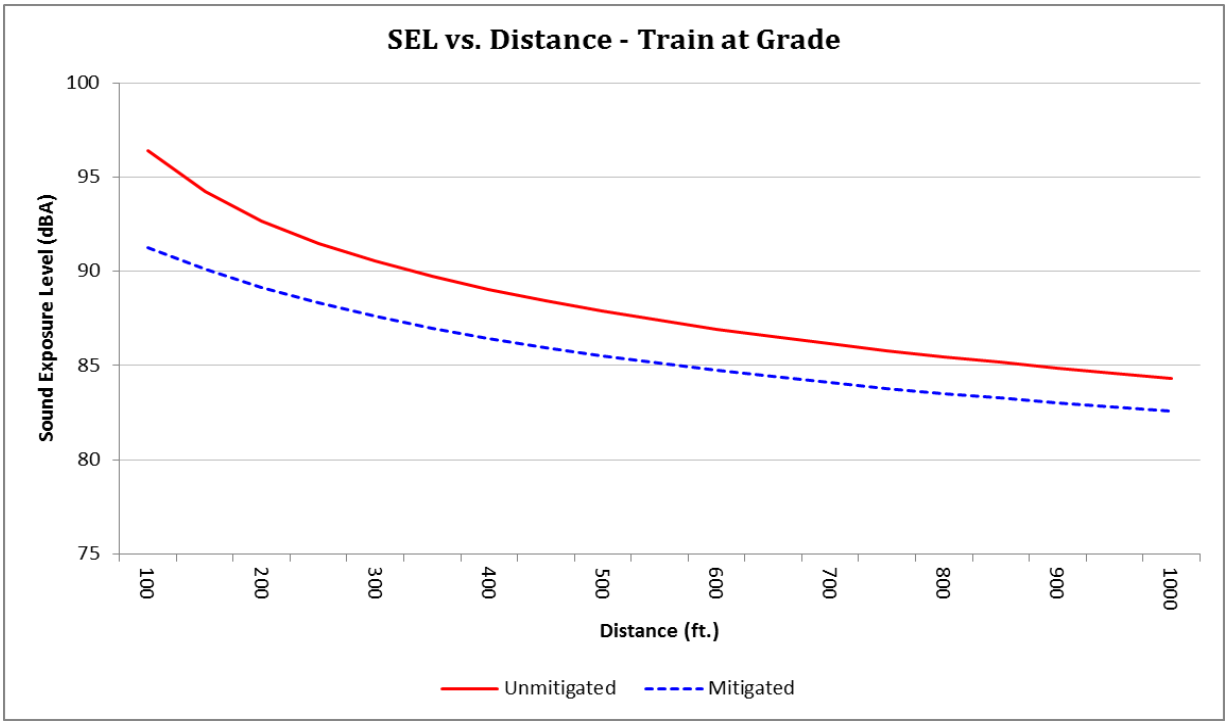
FRA Report Titled "High-speed ground transportation noise and vibration impact assessment" uses this and other research to set the interim criterion of SEL = 100 dB will be used for disturbance by high-speed train operations. A request to the HSR international partners for impacts from high-speed trains on cattle and dairies specifically resulted with responses indicating no documented cases of disruption to cattle.

The most important productivity measure is milk yield. General noise at 105 dB, but not at 80dB, reduced milk yield, rate of milk release, and feed intake by dairy cows (Kovalcik and Sottnik, 1971). Unexpected high intensity noise, such as low altitude jet aircraft overflights (>110 dBA), at milking time could provoke adverse behavior, such as kicking or stomping, that could cause the milking machines to come off or could increase peripheral or mammary release of catecholamines and thereby reduce effectiveness of the milk ejection reflex, decrease efficiency of milk removal, increase residual milk, and lead to overall reduction in milk yield.

Cows exposed to recorded jet noise just before milking showed no behavioral or productivity responses during 21-d treatment periods (Head et al., 1993). Results from this study and others (Ames and Arehart, 1972; Espmark et al., 1974; Kovalcik and Sottnik, 1971) suggest that any response of dairy cows to jet noise around milking would be subtle.
In a report by the U. S. Department of Transportation's Federal Railroad Administration Office of Railroad Development (2005), they state that there is no established criteria relating high-speed train noise and animal behavior. However, some characteristics of high-speed train noise are similar to low overflights of aircraft, and researchers generally agree that high noise levels from aircraft overflights can have a disturbing effect on both domestic livestock and wildlife. Some animals get used to noise exposure, while some do not.

The current knowledge on the sensitivity of cattle to handle noise is limited (Appleby et al., 2008). However, many studies indicates that sudden, novel sounds seem to affect behavior more than continuous high noise that can be predicted by the animals (Head et al., 1993; Grandin, 1997, and Arnold et al., 2007.)

High Speed Train (HST) Noise Production
Below is a graph plotting the HST produced noise levels while traveling 220mph over the distance from the train. The maximum level is 96db at 100 ft. The noise produced by other HST vertical profiles are less than this value; above grade or below grade. Mitigated is defined as placement of a 14-foot soundwall at the edge of right-of-way for this chart.



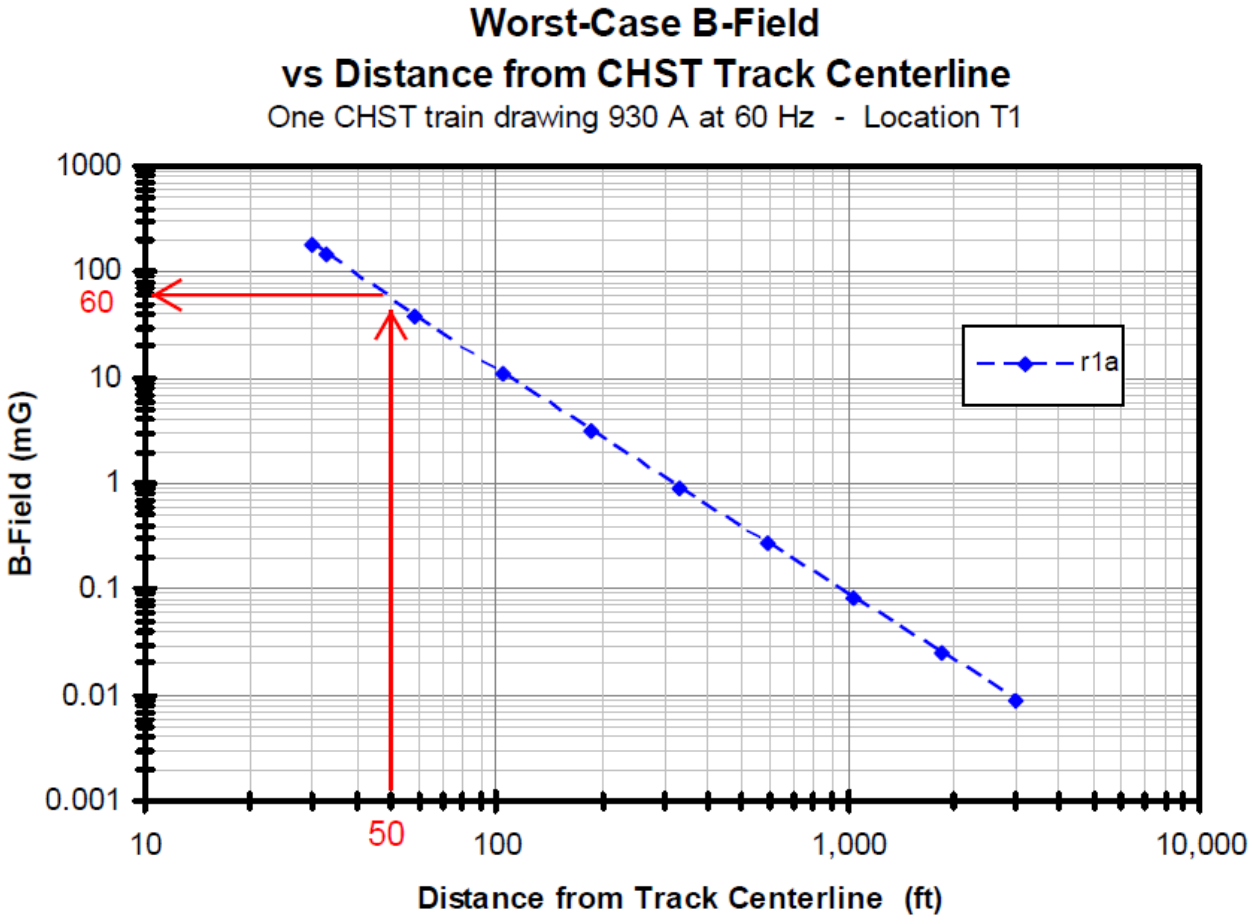
"Sound Exposure Level versus Distance from HST," graphs for HST at-grade and various elevations, prepared for California High-Speed Rail Authority by Ted Lindberg, Senior Acoustical Analyst, URS Corporation, 2/14/2012.

The HST operating at 220 mph would generate vibration levels of 75 VdB at up to 70 feet from the tracks (refer to Section 3.4 Noise and Vibration). As this is below the sound levels created by the HST and thus masked, vibration is generally notable to sensitive receptors such as concert halls. Based on the above graph, mitigation measures may be warranted when facilities are less than 100 ft from the path of the HST.

ELECTRO-MAGNETIC FIELDS

Various studies have examined the effect of electromagnetic fields (EMF) on the health and well-being of dairy cows. Previous studies showed increased feed intake and fat-corrected milk in dairy cows exposed to EMF. The best attempts to evaluate the biological effects of EMF on yield and reproduction variables of cows in a semi-controlled environment have been conducted in Sweden (Algers and Hennichs, 1985) and in the US (Raleigh, 1988). In those experiments, both direct and alternating current lines were used, and variables (fertility, behavior, yield, and health) that were measured for farm animals did not show evidence of an effect attributable to EMF. However, the uniformity of the EMF and sensitivity of the variables assessed varied considerably. Under continuous exposure to 60 Hz AC E&MF, similar to those generated by 735 kV power lines, moderate decreases in milk yield and milk fat percentage were shown with increases in feed intake in non-lactating, non-pregnant dairy cows Burchard, et al (2003). In a study by Rodriguez et al., 2002, cows exposed to EMF (10kV/m, 30μT) had increases in the hormone IGF-1. Also, EMF appeared to have an influence on the timing of changes in the concentrations of growth hormone over a 24-h period and appeared to be associated with an increase in milk yield.

Operation of the HST would generate 60-Hz electric and magnetic fields on and adjacent to trains, including in passenger station areas. Magnetic field measurements have been made in the passenger compartment onboard other HST systems such as the Acela Express (119 mg) and French TGV A (165 mG) and in the operator's cab of the Acela Express (58 mg) and French TGV A (367 mG) (FRA 2006). The graph below shows the maximum possible EMF exposure versus distance. The estimated exposure is about 60milligauss (6microTesla) near the edge of the Right of Way, about 50ft.



From CAHSR: TM 300.07 EIR/EIS Assessment of CHST Alignment EMF Footprint
(with arrows and numeric call outs added for this paper)

The modeled levels of EMF exposure and measurements on other existing HSTs are below the IEEE Standard 95.6 MPE limits of 5 kV/m and 9,040 mG for the public.

The design of the HST system is for the current flow to the train through the catenary system and return flow through the rails and static wires back to the Traction Power Stations. There is the possibility for some current to enter the ground. This can cause corrosion from ground currents along linear metal facilities and nuisance shocks. This would be avoided by installing supplemental grounding or insulating sections in continuous metallic objects in accordance with standard HST designs.

CONCLUSION

A wide range of studies have been conducted concerning noise and or vibration effects on animals, namely dairy cows. Mammals in particular appear to react to noise at sound levels higher than 90dB. Behavioral responses recorded as startle, range from interruption to grazing, turning head, freezing (becoming temporarily stationary), and locomotion from the sound source up to 20 meters. (Espmark, et al. 1974)

Many studies on domestic animals suggest that some species appear to adjust to some forms of sound disturbance. Conclusions from research conducted to date provide only rough estimates of threshold levels for observed animal disturbance. Cows on dairies are constantly exposed to a variety of noises from farm equipment, farm machinery, and work activities that may have habituated them to noises above the presumed threshold for response.

Most of the noise events used in prior studies is related to aircraft over-flights. General noise at 105 dB, but not at 80dB, reduced milk yield, rate of milk release, and feed intake by dairy cows. Consequently, any criteria adopted for effects on animals by high-speed rail noise must be considered interim until further specific research can be conducted. While current research suggests minimal impact beyond 100feet, this is not conclusive and consideration should be given to studies of cattle responses to the HST for conditions where cattle operations are within 350 feet (90db).

Studies examining responses in milk production from dairy cows on exposure to EMF has been variable and non-conclusive. Studies have examined variable and prolonged exposures to EMF. Exposures to 10-kV/m and 30-µT EMF have resulted in minimal health risks to dairy animals as well as milk production. The HSR estimated exposure at the Right of Way is 6-µT further reinforcing the conclusion that there is minimal health risk to dairy animals.

The California High-Speed Rail Authority (CHSRA) design and operations include program elements to account for stray current and EMF risks.

Further research is warranted in all areas, EMF and noise limits, that are related to the possible effects of HST on dairy production.

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